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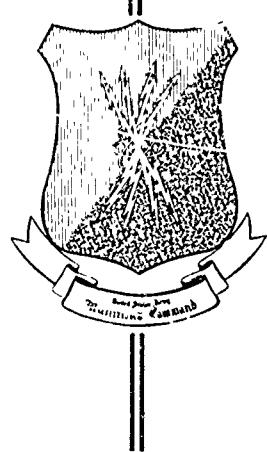
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PICATINNY ARSENAL TECHNICAL REPORT 3049

RADIATION CHARACTERISTICS OF THE XM-13 AND
THE 20 MILLIMETER HISPANO SUIZA
TRACER ROUNDS

M. NOWAK
J. R. STALFY
R. B. DAVIS
W. S. WHEELER

MAY 1963

OMS 5510.12.251B0.01.C1.01

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RADIATION CHARACTERISTICS OF THE XM-13
AND THE 20 MILLIMETER HISPANO SUIZA TRACER ROUNDS

by

M. Nowak
J. R. Stailey
R. B. Davis
Pfc W. S. Wheeler, III

May 1963

Feltman Research Laboratories
Picatinny Arsenal
Dover, N. J.

Technical Report 3049

OMS 5510.12.251BO.01.01.01

Approved:

S. SAGE

S. SAGE
Chief, Pyrotechnic
Laboratory

The work described in this technical report
has been funded by USAERDL and Frankford
Arsenal and is being carried out under the
general direction of Frankford Arsenal.

TABLE OF CONTENTS

| | Page |
|-------------------|---|
| Summary | 2 |
| Discussion | 2 |
| Distribution List | 14 |
| Figures | |
| 1a | XM-13 tracer: energy vs time at 100-millisecond intervals at .64 micron |
| 1b | Hispano Suiza tracer: energy vs time at 100-millisecond intervals at .755 and .852 micron |
| 2a | XM-13 tracer: spectral energy distribution |
| 2b | Hispano Suiza tracer: spectral energy distribution |
| 3a | XM-13 tracer: brightness temperature distribution at .64 micron |
| 3b | Hispano Suiza tracer: brightness temperature distribution at .755 micron |
| 4 | Relative spectral sensitivity of tri X film used with a Corning 2-58 filter |
| 5a | Energy of a blackbody at .64 micron wavelength |
| 5b | Energy of a blackbody at .755 micron wavelength |

SUMMARY

The XM-13 tracer and 20 millimeter Hispano Suiza tracer were tested under static laboratory conditions for their radiant output characteristics in the range of .4 to 1.1 microns. The following information was obtained for both items:

- a. The spectral energy distribution.
- b. Time intensity curve
- c. Average brightness distribution.

DISCUSSION

This laboratory is engaged in a survey of the radiation characteristics of various Ordnance items with the emphasis on the range between 0.4 and 1.1 micron wavelength. The methods of measurement and evaluation of data have been described in Picatinny Arsenal Technical Report 3036, "A Method for Evaluating the Radiation Characteristics of Bright Light Sources as Applied to the XM-108 Tracer." The reader is referred to that report for more details. However, enough information is included in this supplementary report to make the data usable without consulting the original report.

The data pertaining to the XM-13 and Hispano Suiza tracers are presented in Figures 1 through 5, as explained below. The tracers were burned face-up and viewed from a side-on position.

The energy of the XM-13 tracer for an interval of .01 micron at a wavelength of .66 micron is shown as a function of the burning time (Fig 1a). These readings were obtained by viewing the tracer flame with a photocell through an appropriate narrow bandpass filter (shown in Figure 2a), recording the output of the photocell, and comparing it with the output of a standard lamp calibrated by the National Bureau of Standards. In this comparison, the spectral distributions of the standard lamp and the tracer were taken into consideration. At least four satisfactory runs were made; the figure shows that which yielded the highest peak energy.

Figure 1b presents similar information for the Hispano Suiza tracer, with these changes: The .66-micron filter used to find the absolute level of the XM-13 tracer could not be used for the Hispano Suiza because of the low energy in the .66 region. Instead, two filters at .755 and .852 micron were used (the use of an additional filter gave a reliable check on the accuracy of the determination of absolute level).

Figure 2a shows the spectral distribution of the XM-13 tracer. It is an average distribution over the whole visible area of the flame; that is, every element of the burning surface contributed to the spectrum in the same fashion (linearly with area and spectral energy).

A Perkin-Elmer model 108 fast-scanning prism spectrometer was used with two photomultipliers (maximum sensitivities at .33 micron and .8 micron, respectively) as detectors. An N. B. S. calibrated lamp was used as a standard source of spectral energy. Spectral distribution of the item was obtained by comparison of its spectrum with that of the standard lamp. In order to avoid the effect of flickering on the structure of the spectral lines, the output of the photocell used to produce the curve of Figure 1a was displayed with every spectral scan, and only those records with the greatest uniformity over the length of the scan were chosen for evaluation.

For each spectral range, .4 to .6 micron and .5 to 1.1 micron (for the two detectors used), two satisfactory scans were obtained. They were then evaluated, averaged and finally normalized over their common range and combined to give the curve of Figure 2a.

The level (ordinate) of Figure 2a was determined by the peak recorded emission at .66 micron, as indicated by the arrow in Figure 1a.

Figure 2b shows the corresponding spectral distribution curve for the Hispano Suiza tracer, whose level was found by using two filters at .755 and .852 micron.

Figure 3a shows the distribution of brightness temperature over the XM-13 tracer flame as determined by photographic means. Brightness temperature of a given source is defined as that temperature at which the emission $W(\lambda)$ in a given spectral increment $d\lambda$ of a blackbody is equal to the emission of the item. For an item of a complex spectral structure it is very much dependent upon the sensitive region of the detector and should not be confused with the actual temperature. Figure 3a shows the brightness temperature obtained by a combination of photographic

film and optical filter, peaking at .64 micron, whose relative sensitivity is shown in Figure 4. The values were reached by a comparison of the density of the images of the tracer flame with the density of the images of the filament of an N. B. S. standard lamp. At least four independent exposures were made and evaluated, and one most representative of the flame at its highest brightness temperature is shown in Figure 3a.

Figure 3b gives the brightness temperature distribution for the Hispano Suiza tracer. Again, because of low emission in the .64 micron region, the filter-film combination whose sensitivity is shown in Figure 4 could not be used. Instead, high-speed infrared film was used with an interference filter peaking at .755 micron. The relative transmission of this filter is indicated on Figure 2b.

A scale for maximum spectral brightness of the XM-13 was constructed (at the right side of the curve of Figure 2a) by setting the curve at .64 micron equal to the maximum brightness as shown in Figure 3a. A similar scale will be found in Figure 2b; here, the reference wavelength is .755 micron and the maximum brightness is read from Figure 3b.

In Figure 4 the relative sensitivity of the combination of film and cut-off filter used to measure brightness temperature of the XM-13 tracer is shown as determined with a high-resolution grating spectrometer.

Figure 5a shows the energy output of a blackbody at .64 micron versus the temperature. It can be used for the determination of the energy output of the XM-13 tracer at a specific spectral region as discussed in Appendix III of Picatinny Arsenal Technical Report 3036. The corresponding values for a blackbody at .755 micron, to be used with the Hispano Suiza tracer, are found in Figure 5b.

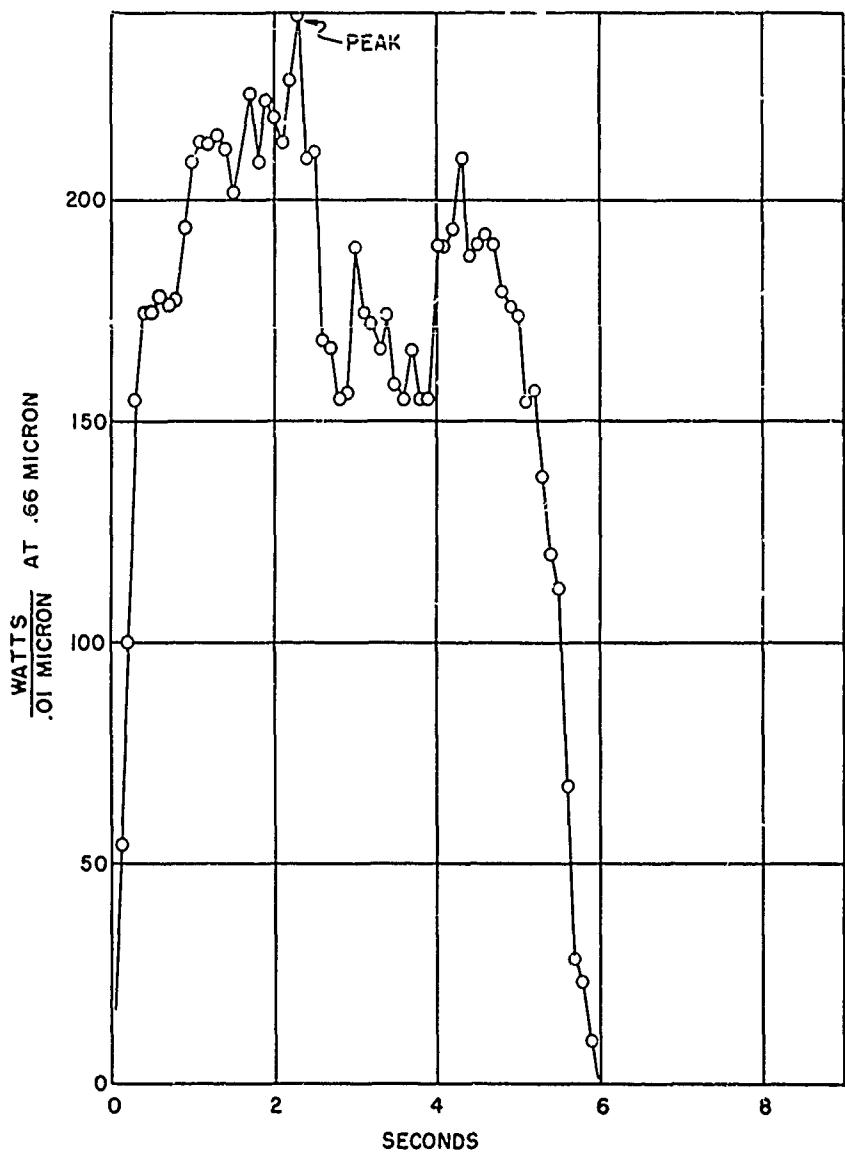


Fig 1a XM-13 tracer: .66 micron energy vs time at 100-millisecond intervals

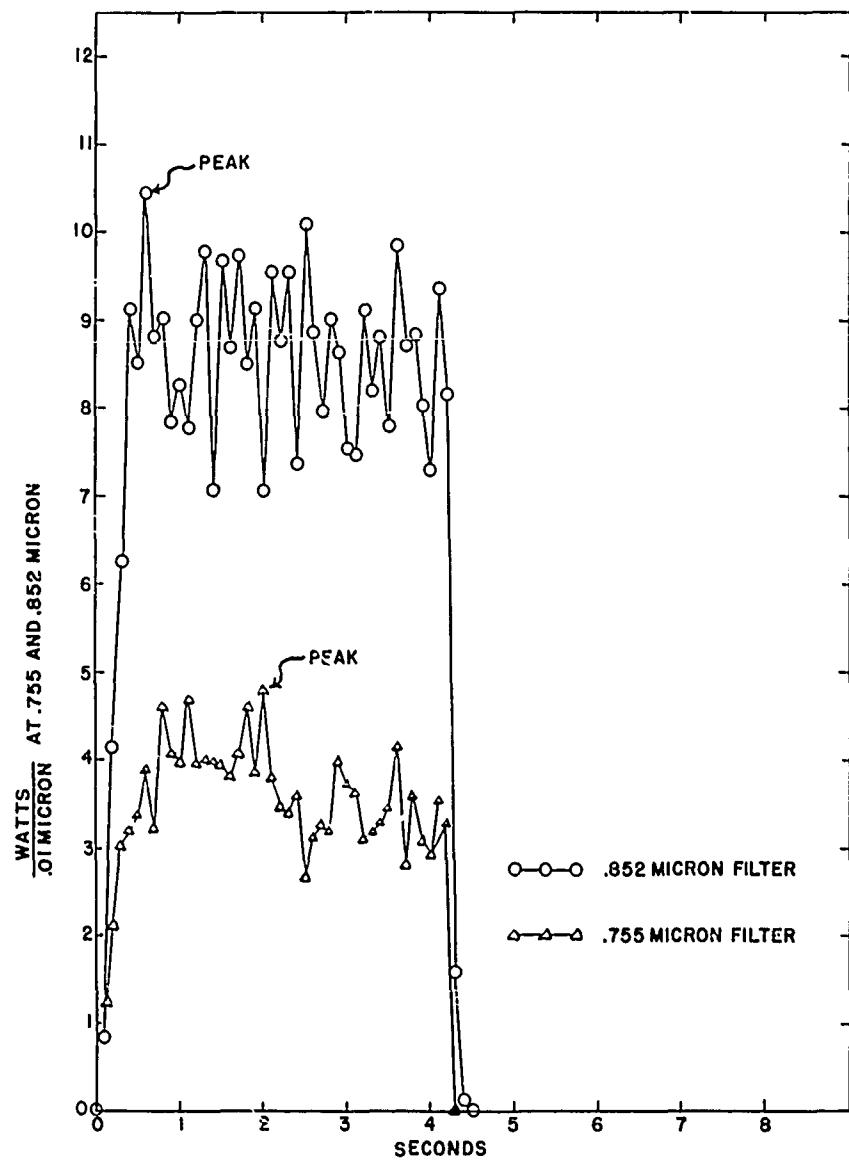


Fig 1b .75 μ and .852 micron energy vs time at 100-millisecond intervals

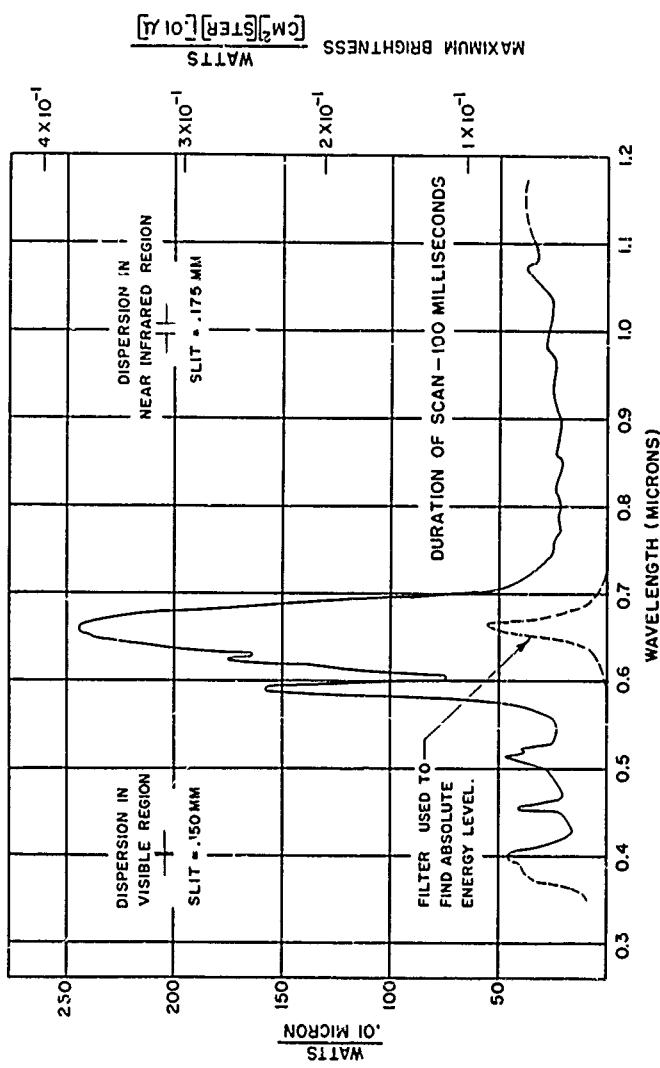


Fig 2a XM-13 tracer: spectral energy distribution of an equivalent point source

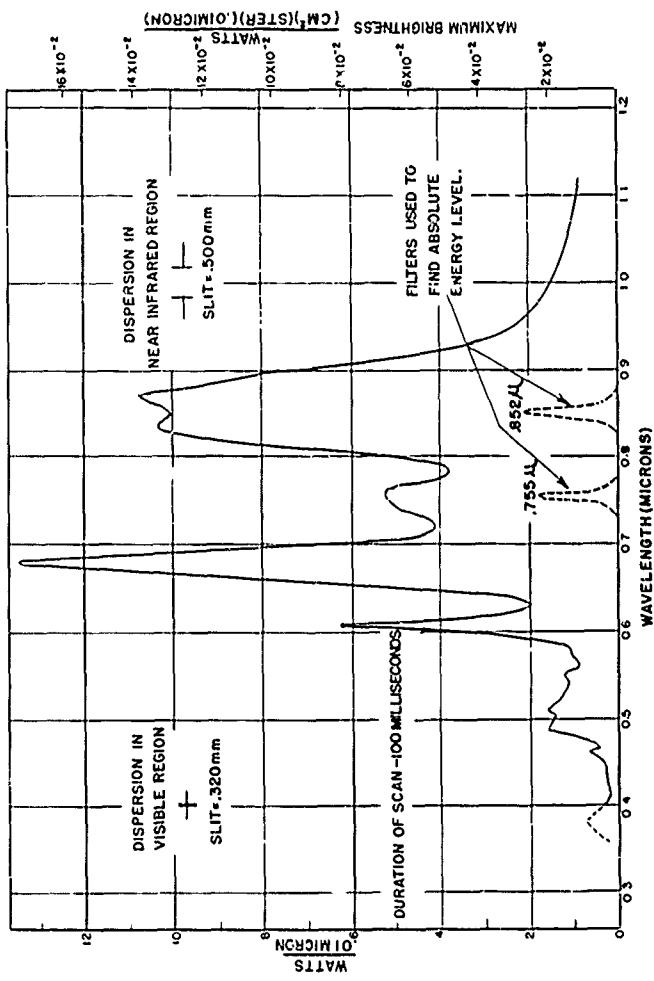


Fig 2b Hispano Suiza tracer: spectral energy distribution of an equivalent point source

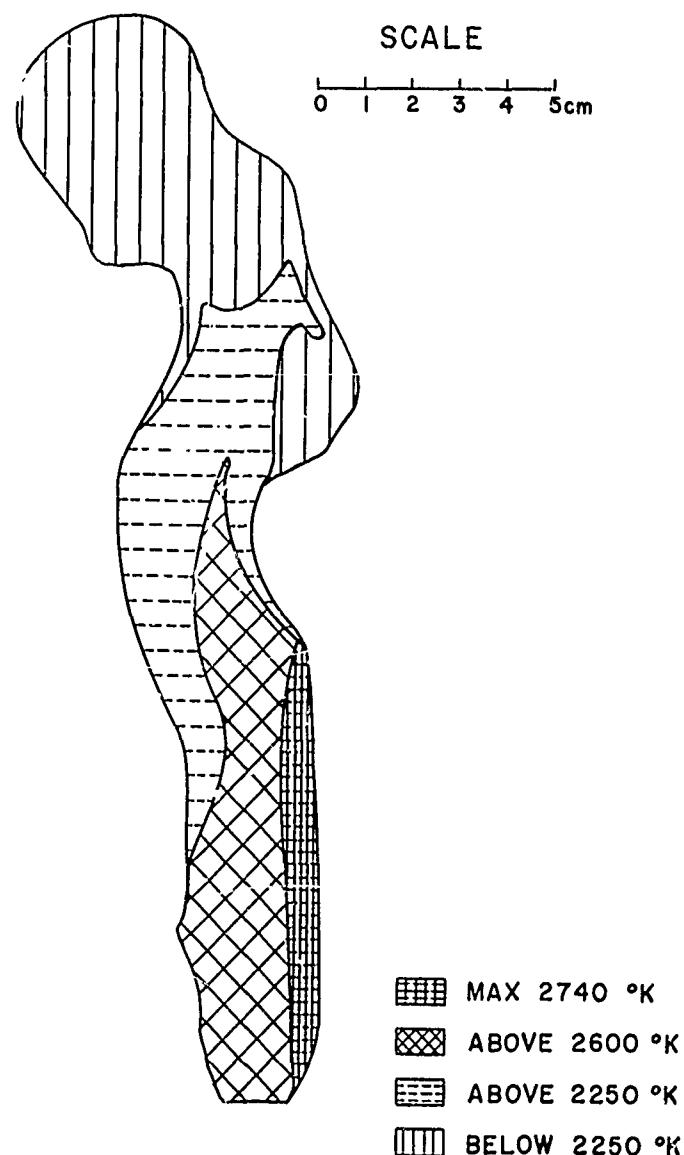
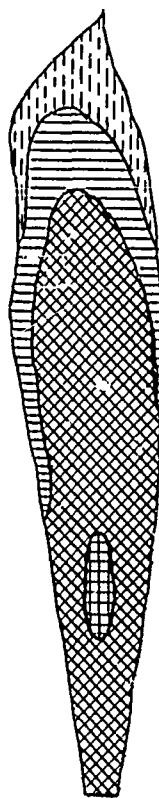


Fig 3a XM-13 tracer: brightness temperature distribution at .64 micron

SCALE

0 1 2 3 4 5cm



■ MAX 2130°K
■ ABOVE 1900°K
■ ABOVE 1700°K
■ BELOW 1700°K

Fig 3b Hispano Suiza tracer: brightness temperature distribution at .755 micron

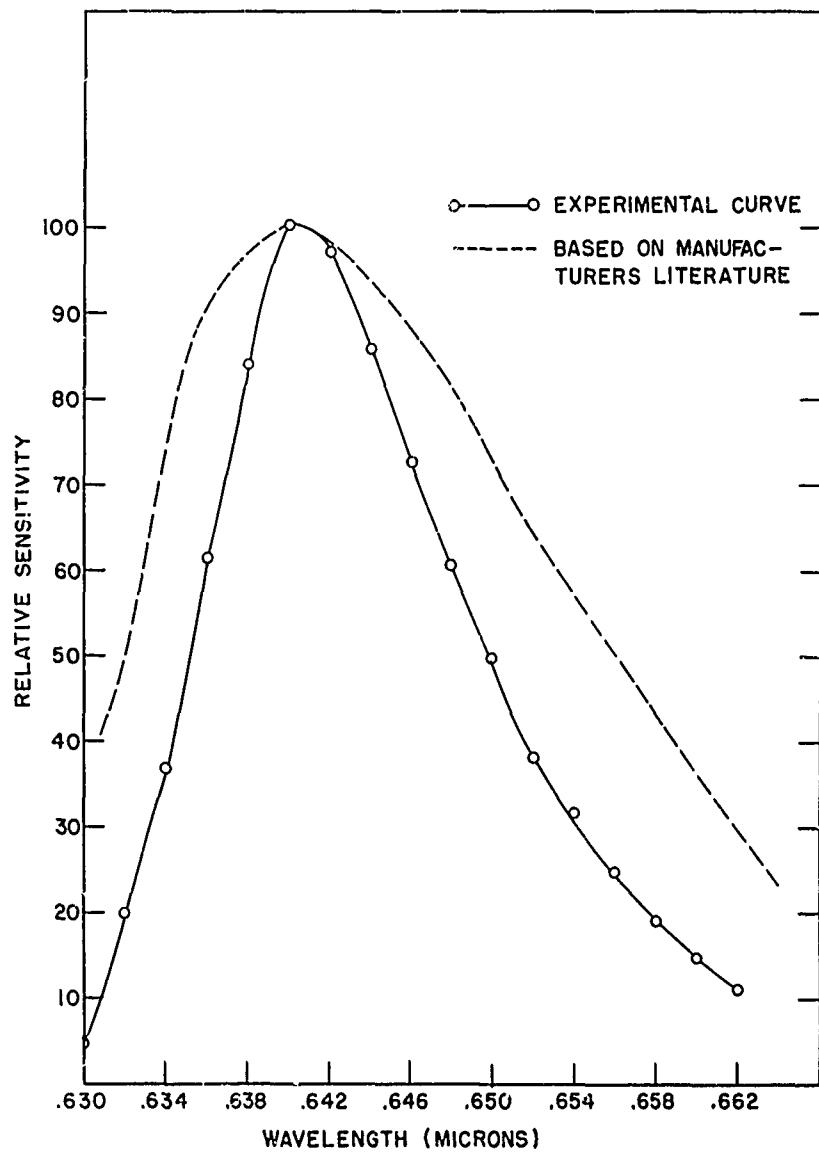


Fig 4 Relative spectral sensitivity of tri X film used with a Corning 2-58 filter

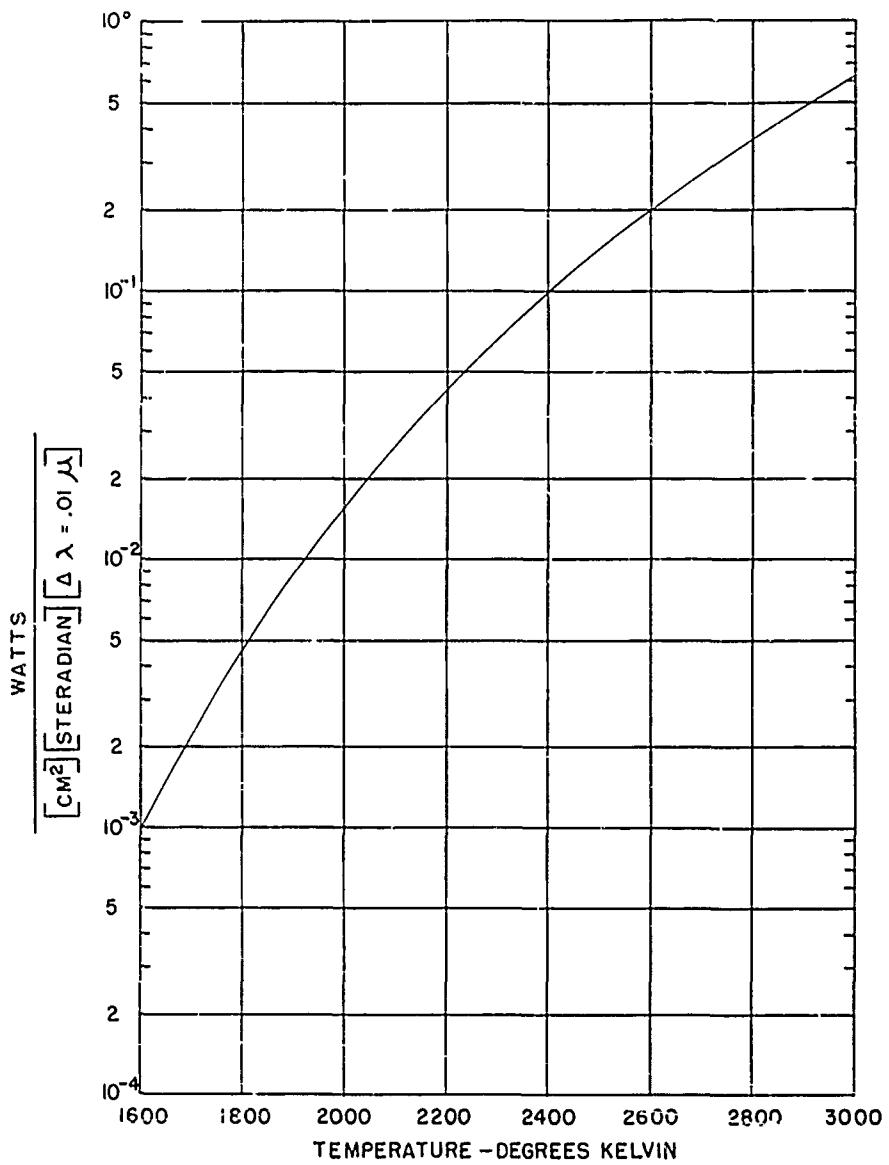


Fig 5a Energy of a blackbody at .64 micron wavelength

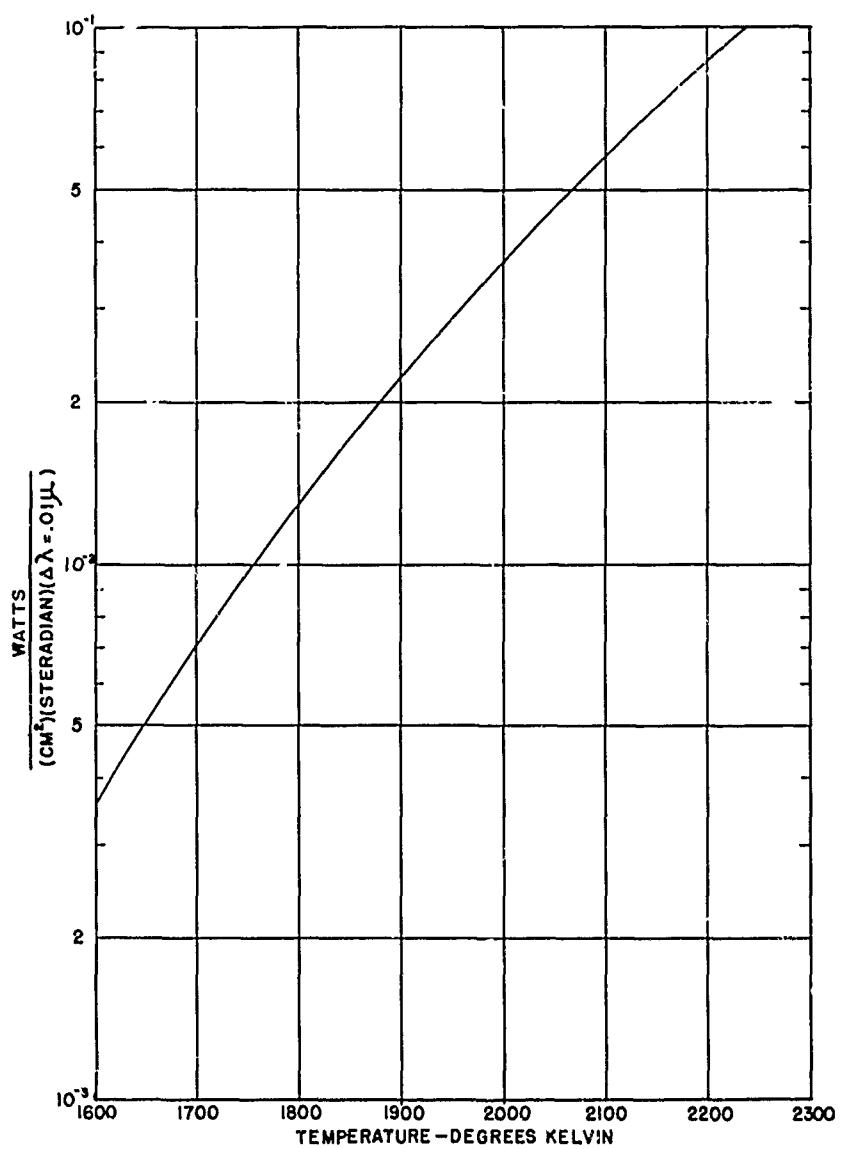


Fig 5b Energy of a blackbody at .755 micron wavelength

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